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IS 11284 (1985): Rotary tube test for iron bearing materials for the manufacture of sponge iron/direct reduced iron(DRI) [MTD 30: Sponge Iron and Smelting Reduction]



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IS : 11284 - 1985

Indian Standard

METHOD OF ROTARY TUBE TEST FOR IRON BEARING MATERIALS FOR THE MANUFACTURE OF SPONGE IRON/DIRECT REDUCED IRON (DRI)

UDC 669.181.42



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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

October 1985

AMENDMENT NO. 1 APRIL 2008
TO
IS 11284 : 1985 METHOD OF ROTARY TUBE TEST FOR
IRON BEARING MATERIALS FOR THE MANUFACTURE
OF SPONGE IRON/DIRECT REDUCED IRON (DRI)

(Page 3, clause 2.1, line 2) — Substitute '5-20 mm' for '6-20 mm'.

(Page 3, clause 2.1, line 3) — Substitute '3 mm' for '1 mm' and '3 - 15 mm' for '1 - 15 mm'.

(Page 3, clause 2.1, line 4) — Substitute '3 - 6 mm' for '1 - 6 mm'.

(Page 3, clause 2.1, line 7) — Substitute 'relevant parts of IS 1493*' for 'IS : 1493 - 1959*'.

(Page 3, clause 3.1, line 2) — Substitute 'IS 460 (Part 1) : 1985' for 'IS : 460 (Part 1) - 1978' and 'IS 460 (Part 2) : 1985' for 'IS : 460 (Part 2) - 1978'.

(Page 3, footnote marked ‡) — Substitute '(third revision)' for '(second revision)'.

(Page 3, clause 4.1, last sentence) — Substitute the following for the existing:

'The rotary tube is provided with arrangement of rotating it at a variable speed of 3-27 rev/min (normally operated at constant speed of 8 rpm) and admitting inert gas during the cooling period.'

[Page 4, clause 5.1(a), Ore size] — Substitute '5 - 20 mm' for '6 - 20 mm'.

[Page 4, clause 5.1(a), Coal size] — Substitute '3-15 mm' for '1-15 mm'.

(Page 4, clause 5.2.1) — Add the following at the end of the last sentence:

'or retained in the furnace'.

(Page 4, clause 5.2.2) — Substitute 'IS 1607 : 1977*' for 'IS : 1607 - 1960*'.

*(Page 4, footnote marked *)* — Substitute 'Methods for dry-sieving (first revision)' for the existing.

Amend No. 1 to IS 11284 : 1985

(*Page 5, clause 6.1.1*) — Substitute 'IS 10823 : 1994*' for 'IS : 10823-1984*'. .

(*Page 5, footnote marked **) — Add '(first revision)' at the end.

(MTD 30)

Reprography Unit, BIS, New Delhi, India

Indian Standard

METHOD OF ROTARY TUBE TEST FOR IRON BEARING MATERIALS FOR THE MANUFACTURE OF SPONGE IRON/DIRECT REDUCED IRON (DRI)

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Indian Standard

METHOD OF ROTARY TUBE TEST FOR IRON BEARING MATERIALS FOR THE MANUFACTURE OF SPONGE IRON/DIRECT REDUCED IRON (DRI)

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 May 1985, after the draft finalized by the Sponge Iron Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 In recent years, sponge iron has gained prominence as a feed stock for steel making in electric arc furnace or in oxygen steel making processes. Suitability of any of the proposed raw material combination plays a significant role during the production of sponge iron. For ensuring, whether the proposed combination of ore and coal, in principle, is suited for direct reduction in rotary kiln process, it was felt necessary to formulate this standard covering a method of testing of raw materials to determine the reducibility of ore and degradation of iron ore and coal during sponge iron manufacture.

0.3 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard prescribes the rotary tube test method to determine the reducibility of iron ore and degradation behaviour of iron ore and coal during sponge iron production by simulating the reduction conditions of rotary kiln.

2. SAMPLE PREPARATION

2.1 The raw materials shall be reduced to the size normally applied in industrial plants. The iron ore lumps shall be crushed to a size below 20 mm in a jaw crusher and the coal to a size below 15 mm in a

*Rules for rounding off numerical values (revised).

roll crusher. After crushing, the lump ore shall be screened at 6 mm and ore of 6-20 mm fraction used for test. The coal shall be screened at 1 mm and the fraction of 1-15 mm used for the test. Detail screen analysis for the coal 1-6 mm, 6-10 mm, 10-15 mm and screen analysis of the ore at 6-10 mm, 10-15 mm and 15-20 mm shall be reported along with the results. Ore and coal shall be chemically analyzed, in accordance with the methods given in IS : 1493-1959* and the relevant parts of IS : 1350†.

3. TEST SIEVES

3.1 Test sieves shall be of the square mesh type and shall conform to the requirements given in IS : 460 (Part 1)-1978‡ or IS : 460 (Part 2)-1978‡.

4. TEST EQUIPMENT

4.1 Rotary Tube — The laboratory type rotary tube consists of a heat resistant steel tube with an inside diameter of 150 mm and a reaction zone length of 650 mm. Its total length shall be 1 450 mm. The rotary tube tapers on its both ends to 90 mm inside diameter. The rotary tube is provided with arrangement of rotating it at a variable speed of 3-27 rev/min and admitting inert gas during the test.

4.2 Furnace — The furnace shall be heated electrically having the heating elements in the spiral form, inserted in the refractory lining of the heating chamber. The external dimension of the heating chamber and furnace shall be as follows:

Furnace width, approx	— 1 200 mm
Furnace height, approx	— 1 400 mm
Total length, approx	— 2 870 mm
Supply voltage	415 V 50 Hz
Power	— 20 kW
Maximum current	— 28 A
Maximum operating temperature	— 1 150°C

4.2.1 Both front sides of the furnace shall have a gas tight sealing. For charging and discharging of the sample, the stationary head of the inlet side shall be equipped with a rubber gasket. A thermocouple shall be provided at the centre of the reaction zone through the sealing flange and shall be connected with a temperature controller to control the temperature in the rotary tube.

4.3 A typical test equipment has been given in Fig. 1, for illustration.

*Methods of chemical analysis of iron ore.

†Methods of test for coal and coke.

‡Specification for test sieves:

Part 1 Wire cloth test sieves (*second revision*).

Part 2 Perforated plate test sieves (*second revision*).

5. TEST PROCEDURE

5.1 Test Conditions — The test condition shall be as follows:

a) *Kiln Charge*

Mass of ore	1 000 g
Ore size	6-20 mm
Reductant	Coal to be tested
Coal size	1-15 mm
Fixed C/Fe ratio	0.5 (This ratio shall determine the mass of the coal to be charged)

b) *Kiln Conditions*

Temperature of kiln at start of test	— Room temperature
Reduction temperature	— $1\ 000 \pm 10^{\circ}\text{C}$
Heat-up time for reduction temperature	— 120 minutes, <i>Max</i> (recom- mended rate $10^{\circ}\text{C}/\text{min}$)
Reduction time	— 180 minutes
Kiln speed	— 8 rev/min
Kiln atmosphere	— Nitrogen gas

5.2 Procedure — Place the cold tube with the sample in the furnace at room temperature and start rotating it at 8 rev/min. Switch on the furnace and raise the temperature of the sample at the rate of 10°C per minute to the predetermined temperature ($1\ 000^{\circ}\text{C}$) under a neutral atmosphere by passing nitrogen at 3 litres/minutes. Maintain this temperature for a defined period of reduction time (180 minutes).

5.2.1 After the required retention time (180 minutes), cool the sample with nitrogen to 300°C in the furnace, continue rotating at 8 rev/min. For further cooling to room temperature, the tube shall be taken out of the furnace.

5.2.2 After the sample cools down to room temperature, it shall be subjected to magnetic separation. The magnetics and the non-magnetics shall be screened according to IS : 1607-1960*, and their respective mass determined.

*Methods for dry-sieving.

6. TEST REPORT

6.1 The test report shall contain the following informations:

- a) Screen analysis of feed ore and coal,
- b) Screen analysis of magnetics and non-magnetics,
- c) Grain sizewise metallization and chemical analysis of the product — 1 mm and — 3 mm fraction must be reported, and
- d) Reduction degradation behaviour of magnetic product.

6.1.1 The reduction degradation of ore, suitable for sponge iron manufacture should be minimum. The criterion for the ore degradation is the proportion of 1 mm in the reduce product in accordance with IS : 10823-1984*.

*Methods for determination of thermal degradation index (TDI) and reduction degradation index (RDI) of iron oxides: Lump ores, sinter and pellets.

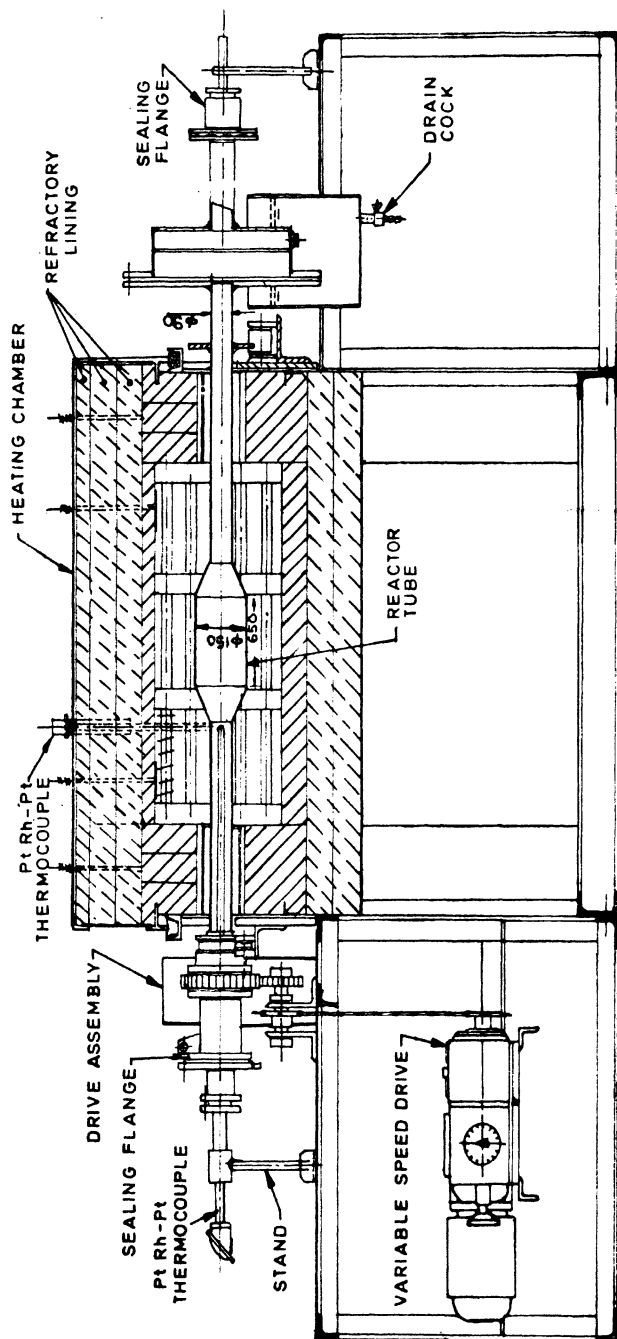


FIG. 1 LABORATORY ROTARY FURNACE



INDIAN STANDARDS INSTITUTION

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones : 3 31 01 31, 3 31 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :

Telephone

*Western : Manakalaya, F9 MIDC, Marol, Andheri (East), 6 32 92 98
BOMBAY 400093

†Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, 36 24 99
Maniktola, CALCUTTA 700054

Southern : C. I. T. Campus, MADRAS 600113 41 24 42

Northern : B69 Phase VII, Industrial Focal Point 8 73 28
S. A. S. NAGAR 160051 (Punjab)

Branch Offices :

'Pushpak', Nurmohamed Shaikh Marg, Khanpur, { 2 63 48
AHMADABAD 380001 { 2 63 49

'F' Block, Unity Bldg, Narasimharaja Square, 22 48 05
BANGALORE 560002

Gangotri Complex, Bhadbhada Road, T. T. Nagar, 6 27 16
BHOPAL 462003

22E Kalpana Area, BHUBANESHWAR 751014 6 36 27

6-8-56C L. N. Gupta Marg, HYDERABAD 500001 22 10 83

R14 Yudhister Marg, C Scheme, JAIPUR 302005 6 98 32

117/418 B Sarvodaya Nagar, KANPUR 208005 4 72 92

Patliputra Industrial Estate, PATNA 800013 6 23 05

Hantex Bldg (2nd Floor), Rly Station Road, 32 27
TRIVANDRUM 695001

Inspection Office (With Sale Point) :

Institution of Engineers (India) Building, 1332 Shivaji Nagar 8 24 36
PUNE 410005

*Sales Office in Bombay is at Novelty Chambers, Grant Road, 89 65 28
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